

California Bay-Delta Program

Science Program Multi-Year Program Plan (Years 4-7)

Implementing Agency:

California Bay-Delta Authority

August, 2003



Multiyear Program Plan (Years 4-7) CALFED-Wide Science

Goals and Objectives

The collaborative process that characterizes the CALFED Bay-Delta program requires transparency, open recognition of scientific uncertainties, and open discussion and publication of scientific findings. As described in the Record of Decision (ROD), it was expected that the Science Program would:

- Respond to emerging questions relevant to the four interconnected CALFED goals;
- Support overlooked or under funded science needs;
- Support greater partnering among agencies, academics and private sector;
- Develop the knowledge base necessary to support accomplishment and perpetuation of CALFED goals; and
- Develop and clarify the status of credible scientific knowledge as it applies to policy decisions

The excerpts of ROD descriptions of science program goals can be found in **Attachment A**. Unlike other CALFED programs, the ROD established broad policy objectives for the science program and few discrete tasks or milestones. The organizational strategy for implementing these goals was designed after the ROD by the Lead Scientist and is contained in these program plans and associated documents (**Attachment B** outlines the activities in the organizational strategy in more detail).

The Science Program has two sets of goals and objectives at any point in time. First, scientific information on specific topics is needed to support a myriad of CALFED decision making, planning, and performance assessments. Second, tasks supporting the growth of new knowledge and synthesis of existing information include soliciting for and funding studies and data analyses on priority issue areas.

Priority Issue Areas

A number of priority issue areas for cross-CALFED science have been identified through a significant amount of input from the CALFED agencies, staff, and the stakeholder community. A detailed description of the rationale behind these priorities can be found in **Attachment C**.

During Years 4-7, the priority issue areas for CALFED-wide science are:

- **Water Operations and Biology:** There are a number of key technical uncertainties associated with the balance between ecosystem protection and water supply reliability for which the Delta is a focal point. These include

impediments to seasonal migration (e.g. DCC closure, DO sag in Stockton ship channel), direct take by the CVP and SWP and indirect take resulting from habitat changes caused by diversions, VAMP and Delta inflows, X₂ and outflow--and the relationship of all these factors to the overall success and vulnerability of different fish species.

- **Performance Assessment:** Understanding the integrated influences of all actions on systemwide response measures (e.g. populations of key species or water supply network flexibility) is a unique responsibility of the CALFED-wide Science Program. Facilitating reviews including systemwide salmonid monitoring, funding studies and monitoring that fills key information gaps needed to help the Authority understand how the net effect of program activities are influencing the accomplishment of program goals, and providing ongoing technical assistance to individual programs in order to integrate performance assessment across all CALFED activities are core objectives for years 4-7.
- **Signature Adaptive Management Projects:** Documenting what works at a regional or watershed scale where multiple CALFED activities are occurring requires more than routine monitoring. Necessary ingredients include interdisciplinary study of existing efforts, creative retrospective approaches and development of new knowledge about how projects affect ecosystems at multiple levels – and a high degree of collaboration with local and regional partners. Organizing and co-funding a set of signature projects will be a major focus of the Science Program over the upcoming three years. Integrated, cross-program approaches for strategic adaptive management projects have already been initiated in Battle Creek, the Yolo Bypass/ lower Consumnes, the Tuolumne, the Merced, and Suisun Marsh.
- **Improving Monitoring Capabilities:** The single greatest gap in scientific knowledge applicable to the response of the system to the suite of CALFED actions is development, analysis and publication of the data that we have already collected, especially where there is the potential for immediate payback. The three priority tasks for Years 4-7 are to invest in data analyses, support reviews of existing monitoring programs such as the review conducted by the IEP its Environmental Monitoring Program to maintain the effectiveness and efficiency of ongoing monitoring programs, and to provide guidance across CALFED programs on designing monitoring efforts to support explanation and performance assessment.

Organizational Goals and Objectives

The second set of objectives and goals for the Science Program is a consistent organizational approach for integrating science across CALFED. These are general enough to be applicable to any issue or problem and ongoing. The two priority organizational objectives for Years 4-7 are:

- **Collaborative Science & Communication:** The effectiveness of science depends upon collaboration among CALFED partners (government and non-government) and wide dissemination of results. The Bay-Delta Science Consortium was initiated for specifically those purposes, and will be used more

and more to support collaboration across institutions, continue publication of the new online journal, and facilitate common data management approaches. Other activities in support of this goal include the publication of fact sheets and material for managers, conferences, and public workshops.

- **Support development of new science within CALFED Programs:** This category of the budget is focused on helping the standing programs develop their internal science activities, by advising and leading development of advisory panels, workshops and new studies, and matching funds on critical science.

Ongoing tasks supporting these objectives include obtaining expert advice and descriptions of the state of knowledge; supporting scientific practices within CALFED such as peer review and the implementation of performance assessment; and conducting transparent discussions of technical issues within the CALFED community in forums such as workshops.

Look Back

Progress

Progress during the first three years of the CALFED Science Program included:

- an intensive effort to clarify and improve the state of knowledge on a number of specific, central issues;
- establishing a practice of seeking external peer review and advice;
- initiating the use of public workshops as forums to publicly discuss complex technical issues;
- developing a common methodology for assessing performance at different scales;
- developing a strategy for monitoring program design and implementing a pilot monitoring program for wetlands restoration;
- providing ongoing advice to individual CALFED programs; and
- developing and implementing a basic organizational design for integrating science throughout CALFED

Issue-Specific Activities

During the first three years, the CALFED Science Program engaged in an intensive effort to clarify the state of knowledge on a number of specific scientific issues central to CALFED decisions. A selection of these activities is presented in Table 1 and a more detailed list of Science Program activities is presented in **Attachment D**.

Issue	Activities
Splittail life history, population dynamics, relations between habitat, flow, population, and potential threats	ERP initiated white paper; Science Program conducted public review of draft at workshop, Jan 2001; studies addressing splittail and floodplain habitat uncertainties initiated

Delta Salinity Responses to Physical Channel Configuration Changes and Operations	Convened workshop on Suisun Marsh levee breach: salinity responses June 2001; funded Delta hydrodynamics study; co-funded Delta Cross Channel hydrodynamic studies
Salmon life history, population dynamics, relations between habitat, flow, population, take, direct and indirect mortality, and potential threats	Initiated an annual workshop to review water operations and environmental water management-related questions; prepared science agenda translating management questions into focused study topics; facilitated discussion of these technical issues in many forums, including the annual EWA review, and the planned (June '03) symposium on OCAP biological assessments.
Delta smelt life history, population dynamics, relations between habitat, flow, population, take, direct and indirect mortality, and potential threats	Initiated an annual workshop to review water operations and environmental water management-related questions; funded completion of white paper and otolith studies; facilitated discussion of these technical issues in many forums, including the annual EWA review, and the planned (June '03) symposium on OCAP biological assessments; supported development of research agenda by IEP workgroup.
Delta water quality	Reviewed baseline water quality analysis for Drinking Water Program; funded additional analysis of existing water quality data; reviewed In-Delta storage project water quality assessment; provided technical advice to drinking water program on science strategies.

Table 1. Selected Science Program Activities During Years 1-3 Related to Specific Issue Areas

External Reviews and Public Workshops

CALFED Bay Delta Science: Reviews 2000 -2004

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2000												Mercury
2001			Stockton Deep Water Ship Channel		Delta Cross Channel				Upper Yuba	EWA Review		
2002								In-Delta Storage	Mercury	EWA Review		
2003							Delta Cross Channel		CalSim II (tentative date)	EWA Review		
2004										EWA Review		

CALFED Bay Delta Science: Workshops and Conferences 2000 -2004

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2000							Adaptive Management Forum - Tuolumne			CALFED Science Conference		
2001	Sacramento Splittail					EWA Salmonid			EWA Delta Smelt	State of the Estuary Conference	Adaptive Management Forum - Merced	Independent Science Board Adaptive Management Prototype
						Hydrodynamics and Salinity						
2002	CALFED Science Conference			Adaptive Management Forum - Clear Creek			EWA Salmonid		EWA Delta Smelt			
				Water Operations and Environmental Protection in the Delta: Scientific Issues								
2003				Performance Measures Staff Training		Salmonid	EWA Salmonid	AFS Early Life History of Fish	EWA Delta Smelt	Battle Creek		
						Environmental Effects of Proposed Long-term Water Operations: Science Symposium on the State of Knowledge				State of the Estuary Conference		
										Wildlife Society Invasive Species		
2004				Adaptive Management Forum - Summary	Flood-plain Restoration	Salmonid	EWA Salmonid		EWA Delta Smelt	CALFED Science Conference		

Performance Measures

The Science Program has developed a template to guide performance measure selection and development throughout CALFED based not only what had already been accomplished by CALFED, but on what has and has not worked well in programs

ranging from similar water management and restoration efforts to business models for sustainability. This template explains how to:

- build program-wide assessments from a combination of project, regional/ classes of projects, and system-wide measurements
- focus monitoring on controlling factors that are expected to change, actually measurable in the field, and directly attributable to specific CALFED actions
- choose indicators that best meet *both* program goals *and* are based on realistic data requirements from a list of desirable measurements

A draft set of prototype performance measures were then developed using this template by a Science Program consultant working directly with CALFED and agency staff directly involved in the Ecosystem Restoration, Levee, Drinking Water Quality, and Water Management programs. These draft prototypes represent indicators that could be described based on currently available data (ie. not requiring additional or immediate staff time for data analysis)—in other words they represent what can be said right now, and are a test of the utility of the Science Program’s template. As more robust indicators are developed, they can be added to or substituted for the prototypes in the portfolio.

As with all scientific products, we are subjecting both the template and the prototype indicators to a peer review process. We have already received a number of significant comments from within the CALFED community and will have addressed those for the prototypes by June 2003. It is important to note that many of the comments consistently highlight data gaps that need to be filled in order to support more robust indicators for tracking complex processes such as population-level changes. After completing revisions to the prototypes, the Science Program will publish them as examples, and use them to help explain what the technical expectations are for performance measures developed by individual programs and to provide a clear and consistent charge to the Executive Science Board which will be responsible for them.

Next steps in developing and implementing performance measures are described in the section on tasks and ROD milestones for Years 4-7.

Monitoring & Data Management Strategy and Activities

Monitoring is critical both for assessing changes effected by CALFED actions and for real-time water and resource management. The Science Program has engaged in a number of activities aimed at enhancing existing monitoring efforts, providing guidance to CALFED programs on monitoring design and program objectives, and, in conjunction with the Ecosystem Restoration Program, filling a critical gap in monitoring the effects of tidal wetland restoration in the Bay and Delta system. Core elements of strategies for monitoring and data management are summarized in Table 4 below.

Table 4. Science Program Monitoring and Data Management Strategies and Objectives	
Guidance on Monitoring Program	<ul style="list-style-type: none"> • Design monitoring to support explanations; assessment will follow • Define gaps and indicators based on specific management questions • Address scale in time and space

Design	<ul style="list-style-type: none"> • No cookie cutter protocols
Enhance and Refine Existing Monitoring Programs	<ul style="list-style-type: none"> • Schedule periodic review of existing monitoring (~5 years) • IEP's review of its Environmental Monitoring Program is example of high quality review and mid-course adjustment • Use external experts in review
Data Management Strategy	<ul style="list-style-type: none"> • Expect multiple, distributed databases • Use common language to facilitate cross-database analyses • Fund data analyses as means to link databases

During the first three years of the program, Science Program staff have been working towards these objectives through a number of different activities, including:

- providing general advice to CALFED agency and program staff on monitoring design and, where possible and appropriate, providing expert advice on specific projects when a science advisor or member of a standing science board has time available to do so;
- forming a team of investigators to conduct a pilot monitoring effort of tidal wetland restoration in the Bay and Delta aimed at describing the effects of restoration on ecosystem processes;
- ongoing coordination with IEP to support and enhance data analyses, periodic subprogram reviews, cross-institutional collaboration, and development of research agendas to support critical CALFED information needs; and
- support of the Bay Delta Science Consortium

Specific future tasks and projects for years 4-7 are described in the Tasks and ROD Milestones section below.

Program Delays

Despite the progress made during the first three years, several significant delays and institutional obstacles have hampered full implementation of the Science Program. The most significant delay has been caused by contracting and fiscal issues. In most cases, the time taken to process contracts with other state agencies and public entities has ranged from 16 to 24+ months. As a result, many program activities related to performance assessment, data analyses, and work conducted by standing Science Boards were delayed by approximately 1 ½ years. While work is progressing, there are still a number of outstanding systemic issues that will continue to hamper progress and are likely to cause additional delays in the future. Core remaining contracting issues are:

- The lack of an established system for securing external peer review and advice from independent scientists. The current contracting process is structured to provide services in an open, competitive environment. For many reasons, it is inappropriate to competitively select scientific reviewers, but no process exists for sole source agreements with individuals serving on review panels.
- Continued and protracted disagreement between state agencies and the University of California (and other public educational institutions) over standard contract terms, including rights in data, and conflict of interest. These disagreements have

resulted in delays of up to 1 year or more in many CALFED contracts. Involving educational institutions in science efforts is critical to the success of the science effort within CALFED and these disagreements jeopardize progress.

- Fiscal issues that arise because of the mismatch between the time funds are appropriated (there is a 3-year time limit on expenditure of some state appropriations) and the time when work can actually begin after a contract is executed (since it has taken over 1.5 years to execute all contracts).

The ROD milestone of appointing a CALFED-wide science board (originally scheduled for June of 2001) was postponed until the system of standing boards and panels (see section below on Program Organization for a more complete description) the relationship between the different groups was tested using the EWA Review Panel and the ERP Independent Science Board in conjunction with Technical Review Panels convened during 2000-20003 to address critical, immediate scientific issues. The Lead Scientist will be bringing a suite of nominations for the Executive Science Board to the Authority for confirmation in August, 2003.

The other ROD milestones are ongoing program objectives, the status of which is described in more detail in the sections above.

In addition to implementation delays, there are also a significant number of scientific issues and requests for workshops and reviews that can not be addressed at current budget levels. A summary of specific unmet needs is in the Year 4 workplan.

Summary of Progress Against Select ROD Milestones

ROD Milestone*	Comment
Appoint an independent science board for the CALFED Program as a whole by the middle of 2001.	Scheduled for Authority confirmation, August 2003
Appoint an independent science panel for the EWA by the middle of 2001.	Completed; Annual review held since Oct 2001
Coordinate existing monitoring and scientific research programs.	Ongoing, see above section for status
Refine the set of ecological, operational and other predictive models that will be used in the evaluative process by the end of 2001.	Ongoing, see performance measure and issue-specific activities above
Establish performance measures and indicators, and a consistent strategy of on-going development of these, for each of the program areas.	Ongoing, see performance measure section above

Develop an annual science report, format and content, which includes:	A. Ongoing, see description of issue-specific activities related to water operations and biology
A. Status of the species and effectiveness of efforts to improve conditions, including EWA, ERP and water management strategies, and provide recommendations to maximize fishery benefits while minimizing impacts to water supply.	B. Ongoing, see performance measure section above
B. Assessment of progress and effectiveness of each program element as indicated by performance measures and indicators.	C. Progress is being made through the Bay Delta Science Consortium, see (see Attachment F)
C. Complete feasibility study to establish and construct CALFED Science Center.	D. Ongoing, included in organization of science advisors (see below) and a range of research agendas developed through activities related to water operations and biology
D. Recommended research and/or program adjustments.	E. Completed
E. Prepare first annual report by the end of 2001.	

*Note that these ROD milestones represent a partial summary of Science Program goals and responsibilities described in the ROD. The program priorities described above represent a more complete synthesis of the ROD goals and objectives.

Cross Program Integration and Linkages

The Science Program has been actively engaged in many cross-program activities. A selected list is in the process of being compiled.

Institutional Structure

There are three distinct organizational approaches used to integrate science activities across the CALFED program. The first organizational structure explains the distinction between the roles and responsibilities of the CALFED-wide CBDA Science Program and the responsibilities of each individual program for science. The second structure explains the system of external reviewers and advisors that the CBDA Science Program has established. The third structure outlines how the roles of the Authority, the CBDA Science Program staff, individual program staff, external panels, and the Executive Science Board work together on a specific issue.

Science Across CALFED and Science Within Each Program

The Science Program is focusing on large-scale issues that cut across multiple program elements and regions. Within each program area, however, there are also specific science and project technical needs including:

- peer review of specific study designs, proposals submitted through proposal solicitations (PSPs), and final technical products
- balanced and unbiased descriptions of the state of science relative to a specific issue
- identifying critical unknowns needed to assess program performance or define classes of activities needed to reach program goals; and
- specific data analyses and monitoring needed to support performance assessment

For example, the storage program is applying these scientific approaches to ensure its feasibility and environmental impact studies use the best available scientific information and to identify the strengths and weaknesses of one of its core tools (Department of Water Resources' CALSIM II model). The Drinking Water Program is applying these approaches to develop a monitoring strategy that will feed into an overall assessment of program performance.

A summary of scientific tasks currently being undertaken by individual programs is listed under "Program-Specific Science" in **Attachment A**.

The following table outlines the distinction between the scientific activities that will be supported and carried out by the CBDA Science Program, and those that should be carried out within individual programs.

CBDA Science Program	Lead Agencies for Individual Programs
CALFED wide Science Board, expert panels examining cross-program issues and studies	Support Program-specific science advisors
Conduct reviews of programs, large-scale activities cutting across program areas, advise on peer review in PSPs, and facilitate inclusion of outside experts	Conduct peer review of specific studies and tools, include peer review in PSP selection process
Develop science agendas for cross-cutting issues, implement agendas by funding regional and large-scale monitoring gaps, signature projects, intensive multidisciplinary studies, and research aimed at building knowledge	Develop strategic science agendas specific to program assessment, fund studies and monitoring to implement agendas
Support multiple communication tools and arenas, including online journal, science conferences and forums	
Invest in information needed to understand the integrated influences of all actions on system-wide response measures	Invest in monitoring and performance assessment of classes of projects and cost-share studies of effects on a large-scale

Organization of Science Boards and Expert Panels

The CALFED agencies committed to the creation of an independent “CALFED Science Board” (i.e., California Bay-Delta Authority Executive Science Board) in the Record of Decision. The concept was that incorporating review, insights and/or advice from independent experts with knowledge and experience relevant to a specific Bay-Delta issue would benefit the actions necessary to achieve the Authority’s multiple goals. The precedent for obtaining advice from academic experts was begun before the signing of the ROD by the CALFED Ecosystem Restoration Program. Subsequently (after September 2000) a formal process for obtaining input from independent experts was developed and now is being progressively implemented by the Authority’s Science Program.

The Science Program’s existing approach for incorporating independent expertise involves three levels of working groups. This somewhat complex system is necessary because of the number of technical issues that are confronted, the depth required to confront each issue effectively, and the different approaches sometimes necessary to obtain review, advice and insights. The Authority’s Science Program and Lead Scientist manage the overall system. A single science board, even with subcommittees, would be overwhelmed by the combination of the number of issues, the immediacy of many needs for review or advice, and the depth of advice the Authority requires. Therefore, the working groups best suited to the needs of the Authority are Technical Panels, Standing Boards, and the Authority’s Executive Science Board. All members of panels, standing boards and the Executive Science Board must meet the criteria for independent experts (**Attachment E**).

Executive Science Board of the CALFED Bay-Delta Authority

The Executive Science Board is a standing board of distinguished experts whose role is to directly advise the Authority’s governing commission on the application of science and the effectiveness of science practices across the Bay-Delta Program (following the model of the Executive Board of the Science Advisory Board of the U.S. Environmental Protection Agency). The Executive Science Board is not asked to pass direct judgment on the success or failure of the Authority’s programs, but to provide insights that can make the science underlying those programs, the application of that science, and the technical aspects of those programs the best they can be. This includes overseeing the goal of explicitly characterizing the status of knowledge and identifying assumptions and uncertainties. Most members of the Executive Science Board will also be members of existing Standing Boards and Technical Panels; thus, each should be familiar with at least some issues of the CALFED Bay-Delta Program (the Executive Board will be designed such that expertise to cover most or all CALFED issues will be included). It is expected that the Executive Board will grow as Standing Boards and Technical Panels are added.

Standing Boards

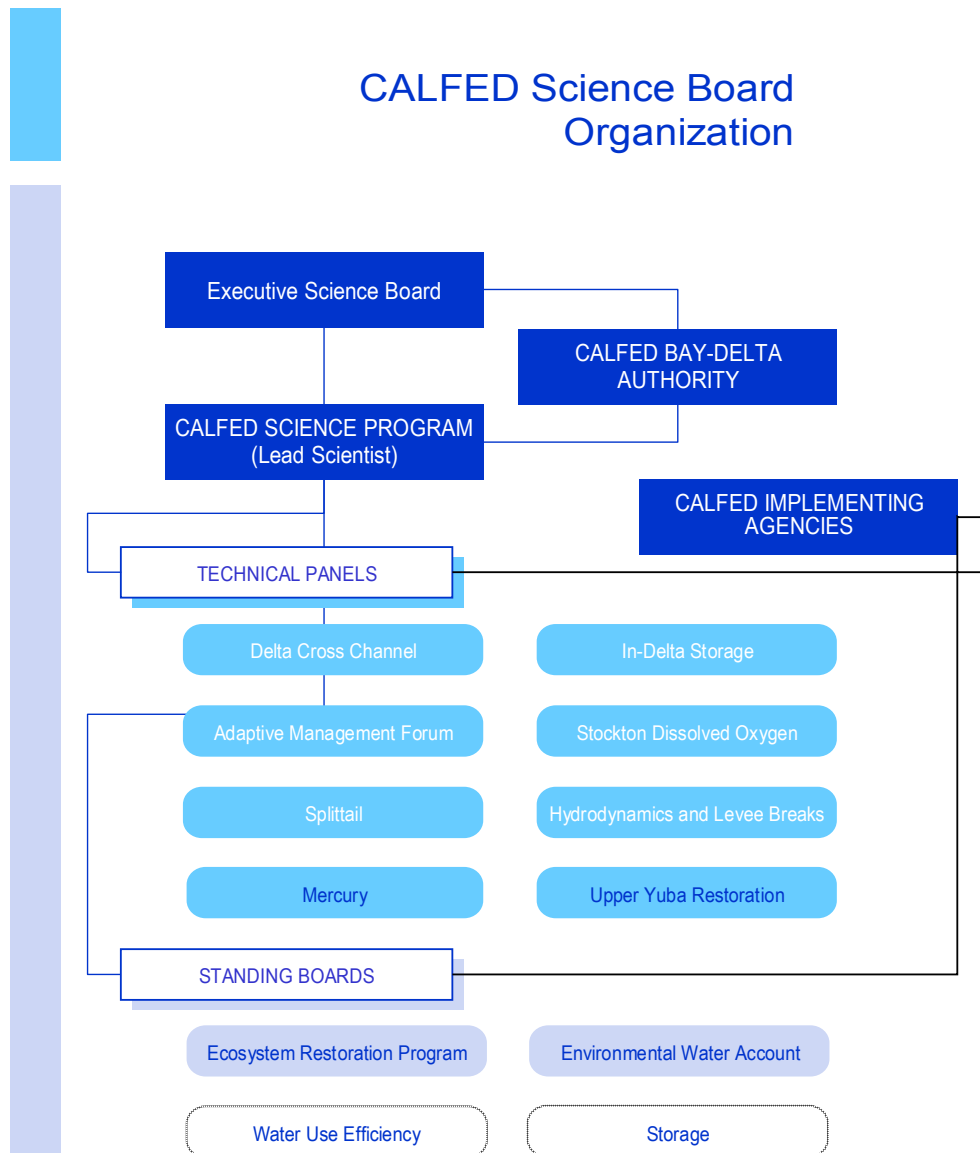
Standing Boards combine the expertise and experience of individuals who together can represent the range of interdisciplinary knowledge of the variety of issues and challenges that converge in a program, a complicated issue, a specific region (e.g., the Delta), or a circumstance where multiple issues collide. It is expected that many of these

individuals will or will have participated in detailed analyses of narrower issues (e.g., on the Technical Panels). Thus the Standing Boards will bring to bear the nation's best expertise on the Bay-Delta's most complicated and many-faceted issues, and bring continuity to that effort. Each Board will be composed of experts appointed by the Lead Scientist in collaboration with the particular standing program of the Authority. Standing Boards (or members) review, advise, provide insights, and raise questions that help the Authority anticipate upcoming issues; evaluate scientific practices or issues; and help develop scientifically sound programs to complement each standing program's actions. The Ecosystem Restoration Program established a standing Board in 2000; the Environmental Water Account Review Panel; and the Water Use Efficiency Science Review Committee are all examples of standing boards in place or soon to be in place.

Technical Panels

Technical Panels provide expert input on individual issues, most of which have a finite timeline. Although these are ad hoc groups (each will eventually sunset), they meet and re-meet over the full term of the issue they are addressing. These groups work at the greatest level of detail. Each panel includes the full range of disciplinary expertise that spans the particular issue. Balanced perspectives will be a key in all groups. Some members will participate in Standing Boards and some will not. Three examples of issues that are being (or have been) addressed using such panels follow. Other examples are available if desired.

CALFED Science Board Organization

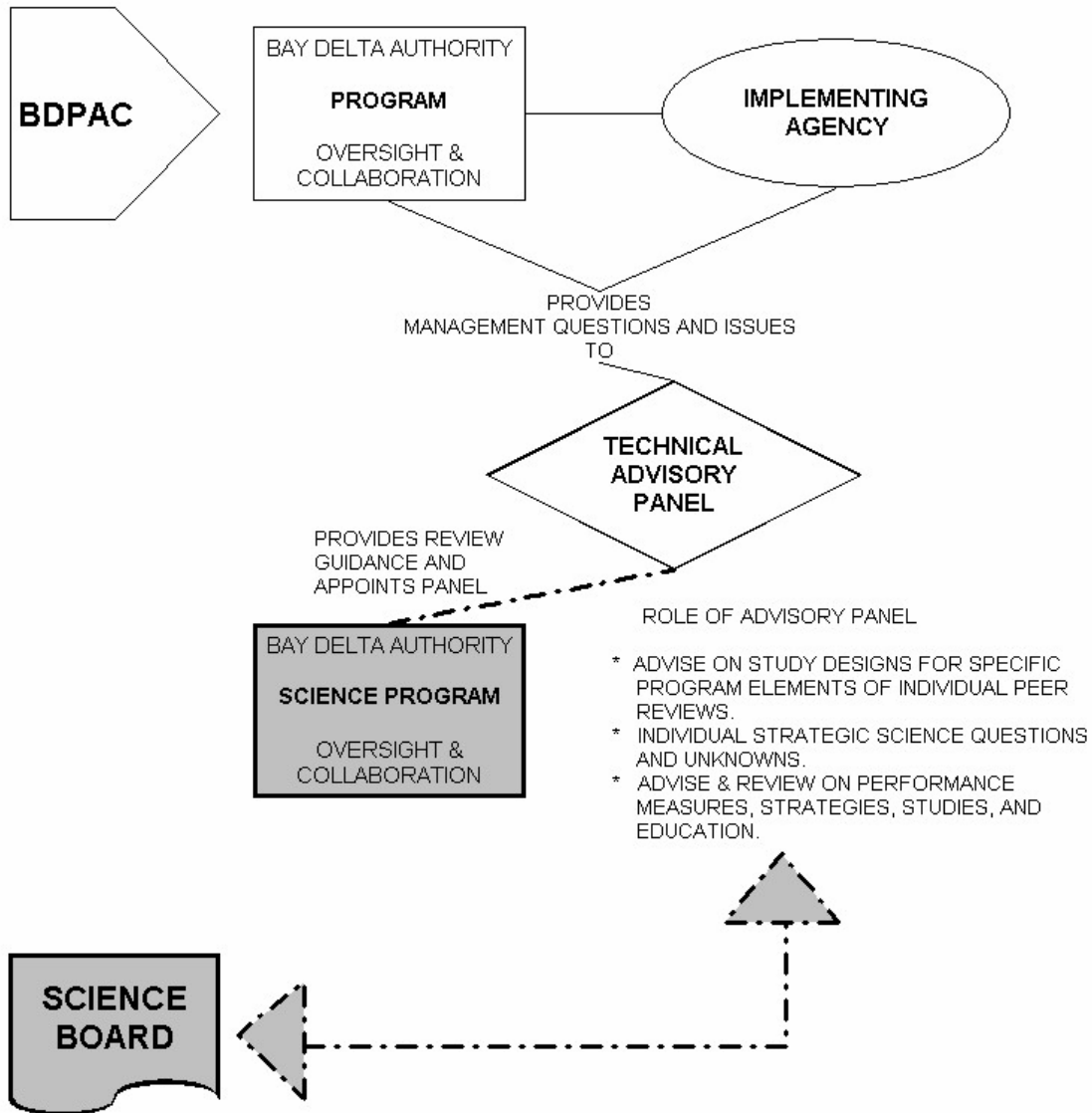


Interactions Between CALFED Program Organization and Science Organization

Integration of scientific advisors and external reviewers into a fluid resource management program is most effective when the roles and expectations of outside advisors are clear from the outset, and resource managers and policy makers are clear with regards to the questions they are trying to answer. The schematic below describes how an advisory panel receives its charge from both the management questions posed by program staff and stakeholders and from the Science Program staff who use program

input to frame a specific charge that elicits constructive technical information. Similarly, using input from program staff, the Science Program will formally appoint panel members. The Executive Science Board’s role is to provide oversight on all reviews conducted within CALFED to assure the process remains balanced and credible.

Program Organization



Science Organization

Tasks and ROD Milestones

The six priority areas for CALFED-wide science during Years 4-7 are:

- Water Operations and Biology
- Performance Assessment
- Signature Adaptive Management Projects
- Improving Monitoring Capabilities
- Collaborative Science and Communication
- Supporting the Development of New Science Within Individual CALFED Programs

The following is a description of budgets, schedules, and tasks specific to each of these priority areas.

Water Operations and Biology: Issue-Specific Activities

The nexus between water operations and biology underlies many of the core policy and management issues being addressed by CALFED. During Years 4 and 5, the Science Program's three top priorities are to (a) continue supporting open public discussion about key technical issues and uncertainties in the context of program evaluations and decision making (e.g. EWA, South Delta fish facilities, OCAP, etc.); (b) fund publications linking the state of knowledge to policy issues; and (c) conduct competitive proposal solicitation processes (PSP) and fund resulting studies and data analyses that will fill critical information gaps related to water operations and biology.

The first two tasks are ongoing (specific workshop topics have been identified for Year 4). The Science Program's first PSP will take place during Year 4 and will identify studies to be funded from Year 4 and Year 5 funds. The list of critical information needs to be addressed in that PSP is presented in more detail in the Year 4 workplan; this list will be revised during Year 5 in preparation for a second PSP in Year 6.

Years 4-7 Water Operations and Biology Tasks and Schedule

WATER OPERATION AND BIOLOGY TASKS AND SCHEDULE	Year 4				Year 5				Year 6				Year 7			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Conduct a PSP to fill critical information gaps*																
Support for salmonid recovery program																
Cost-share ongoing multidisciplinary Delta hydrodynamic/fish studies																
Fund and design workshop on science needs for Delta smelt recovery																
Additional workshops on water ops & biology topics																

Years 4-7 CBDA Science Program Task Needs – Water Operations and Biology

Task	\$ in millions				
	Year 4	Year 5	Year 6	Year 7	Total
Ongoing support (1/2) of multidisciplinary hydrodynamic, fish, and water quality studies in Delta	0.8	0.8	0.8	0.8	3.2
Conduct a PSP and fund critical information gaps	5.0	1.2	0.2	0.2	6.6
Ongoing workshops on specific technical issues critical to recovery and water management planning	0.6	0.6	0.6	0.6	2.4
Fund information syntheses linking knowledge to policy decisions	0.7	0.4	0.4	0.4	1.9

Performance Assessment

Within Individual Programs

The Science Program has defined a number of elements that are needed within each program area in addition to those needed program-wide in order to fulfill ROD commitments. Each individual CALFED program has been asked to identify budgets and tasks for incorporating peer review, data analysis and new studies of critical unknowns, program-specific science advisors, and monitoring and performance assessment into their multi-year program plans.

For performance assessment, four specific pieces of information were requested:

- a general assessment of the current status of the performance measure portfolio for your *program/area* using the methodology developed by the Science Program
- a description of the program's overall strategy for incorporating performance assessment in program plans and when periodic assessments of planned program actions will take place based on the results of performance data or other new information
- a description of which performance measures the program will be working on for the period between July 1, 2003 to June 30, 2006, the nature of the planned tasks, budget, and plan for publication and dissemination of results
- an update of a draft list of potential performance measures prepared in 2001

A more detailed workplan based on these strategies will be prepared over the summer. The draft of those workplans will be reviewed by Science Program staff and expert advisor in a working session with staff from all CALFED programs, then brought before the Authority during the 2004 program review cycle.

INDIVIDUAL CALFED PROGRAMS	Year 4				Year 5				Year 6				Year 7			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Prepare detailed workplans for individual programs																
Review by Authority																
Implement detail workplans																
Schedule assessment																

CALFED-wide CBDA Science Program

There are three major activities being undertaken by the CBDA related to performance assessment: developing and providing guidance to individual CALFED programs (including review of performance measures by the Executive Science Board), collaborating with the water management, drinking water, levee, and drinking water quality programs to define and use performance measures for the four major program goals, and planning a review of the Science Program in comparison to science in other large-scale water management and ecosystem restoration programs.

CBDA SCIENCE PROGRAM	Year 4				Year 5				Year 6				Year 7			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Ongoing development of cross-program accomplishments																
Support ongoing review of tidal wetlands restoration																
Solicit and fund studies to fill cross-program gaps																
National Academy comparative review																

Years 4-7 CBDA Science Program Task Needs – Performance Measures

Task	\$ in millions				
	Year 4	Year 5	Year 6	Year 7	Total
Support continued development of program-wide performance measures	0.3	0.3	0.3	0.3	1.2
Ongoing review of tidal wetlands restoration monitoring	0.7				0.7
Solicit for and fund new data collection, analyses, or pilot studies where existing data is inadequate		0.7	0.4	0.7	1.8
National Academy of Sciences review of science in CALFED compared to other efforts			0.3		0.3
sub total	1.0	1.0	1.0	1.0	4.0

Signature Adaptive Management Projects

Some places in the Bay-Delta and its watershed offer opportunities for immediate advances in meeting CALFED's goals and intensive assessment of the effects of

investments by a number of different CALFED programs. A number of locations in the system have been focal points for CALFED activities, including:

- Battle Creek, where a workshop to define science needs will be held
- Suisun Marsh, where restoration and water management converge, prospects for restoration successes are substantial, and scientific uncertainties regarding outflow and habitat are best studied;
- Merced River, where questions such as “can we restore geomorphic processes on rivers below dams?” and a thorough assessment of restoration activities can be undertaken
- Tuolumne River, where an integrated, cross-program study of the links between water management, watershed activities, ecosystem restoration, and water use efficiency can be undertaken
- Yolo Bypass/ lower Consumnes riparian areas, where an integrated, cross-program study of flood control and floodplain restoration and associated benefits for native species can be undertaken.

Efforts in each of these areas are already underway, led by different CALFED programs and external collaborators.

During Years 4-7, the Science Program will support the formation of conceptual models and integrated project proposals, external reviews of these proposals, development of teams of scientists in collaboration with practitioners, and co-fund scientific elements of signature projects. The Bay Delta Science Consortium will facilitate collaboration of signature projects in the Bay and Delta region.

Years 4-7 Tasks and Schedule

Signature Adaptive Management Projects Tasks and Schedule	Year 4				Year 5				Year 6				Year 7			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Convene workshop on Battle Creek to define science needs*																
Support strategic planning on recommendations by AMR review (Merced)																
Solicit and fund collaborative proposals on key Suisun Marsh and associated water management/biology questions																
Support strategic and conceptual planning of cross-program integrated signature projects																
Solicit and fund collaborative adaptive management studies																

Years 4-7 CBDA Science Program Task Needs – Signature Adaptive Management Projects

Task	Year 4	Year 5	Year 6	Year 7	sub total
Convene workshop on Battle Creek to define science needs*	0.2				0.2
Support strategic planning on recommendations by the Adaptive Management Forum review (Merced)#					0.0
Solicit and fund collaborative proposals on key Suisun Marsh and associated water management/ biology questions in PSP	0.3	0.7			1.0
Support strategic and conceptual planning of cross-program integrated signature projects (Consumnes, Tuolumne, etc.)		0.3	0.3	0.1	0.7
Solicit and co-fund collaborative adaptive management studies			0.5	0.2	1.9
sub total	0.5	1.0	0.8	0.3	
				TOTAL	3.8

*Soliciting for proposals to fill identified needs for Battle Creek will be carried out cooperatively by ERP and the Science Program

#Support during Year 4 from previous years' funds; identified activities will be funded by ERP

Improving Monitoring Capabilities

The single greatest gap in scientific knowledge applicable to the response of the system to the suite of CALFED actions is development, analysis and publication of the data that we have already collected, especially where there is the potential for immediate payback. The three priority tasks for Years 4-7 are to invest in data analyses, organize and support reviews of existing monitoring programs such as the review conducted by the IEP its Environmental Monitoring Program to maintain the effectiveness and efficiency of ongoing monitoring programs, and to provide guidance across CALFED programs on designing monitoring efforts to support explanation and performance assessment. The Science Program will continue to coordinate with IEP with respect to planning for and meeting unmet CALFED information needs.

Years 4-7 Schedule and Tasks

Improving Monitoring Capabilities Tasks and Schedules	Year 4				Year 5				Year 6				Year 7			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Conduct competitive solicitations and fund fellowship proposals for analysis of existing data																
Fund analyses of IEP data on fish distributions and trends																
Organize review of systemwide salmonid monitoring																
Review pilot tidal wetlands restoration project																
Provide guidance and reviews of individual monitoring strategies and plans																

Years 4-7 CBDA Science Program Task Needs – Improving Monitoring Capabilities

Task	\$ in millions				
	Year 4	Year 5	Year 6	Year 7	sub total
Conduct competitive solicitation and fund fellowship proposals for analysis of existing data	1.8	1.8	1.8	1.8	7.2
Fund analyses of IEP data on fish distributions and trends	0.3	0.3	0.3	0.3	1.2
Organize review of systemwide salmonid monitoring		0.2			0.2
Review pilot tidal wetlands restoration project				0.3	0.3
Provide guidance and reviews of individual program monitoring strategies and plans	0.1	0.1	0.1	0.1	0.4
sub total	2.1	2.4	2.1	2.5	
				TOTAL	9.3

Collaborative Science and Communication

The effectiveness of science depends upon collaboration among CALFED partners (government and non-government), clear articulation of the relevance of new scientific information to management and policy issues, and a wide dissemination of the results of technical work.

There are several major, ongoing tasks being undertaken by the Science Program to support increased and effective collaboration. The Bay Delta Science Consortium (**Attachment F**) is a collaborative effort involving most of the CALFED agencies and many of the research institutions in the Bay and Delta areas. The Science Program will use the Consortium more and more to support collaborative science across institutions, continue publication of the new online journal, and facilitate common data management approaches.

The second major task under this objective is supporting the publication of peer reviewed technical information relevant to the Bay-Delta watershed and support of communication of new scientific findings amongst members of the CALFED technical community. Ongoing activities under this task include continued publication of the new electronic journal "San Francisco Estuary and Watershed Science" (target launch data of June 1, 2003; hosted by the University of California's Digital Library), the biennial CALFED Science Conference, and syntheses of scientific information by experts on specific topics (white papers).

The third major task is ongoing communication of the relevance of new scientific information to managers and policymakers. This is being undertaken through the publication of periodic fact sheets on specific issues (see the Science Program website for back issues), summaries of new information presented at science conferences that explicitly highlight its relevance for management, and co-sponsorship of the biennial State of the Estuary Conference.

The fourth major task involves funding expert advisors and conducting peer reviews. This task includes providing leadership activities to and staff support for the Executive Science Board and the EWA Review Panel, sharing these functions with other programs for other standing boards and technical panels, organizing peer review panels, and managing technical reviews during competitive proposal solicitations.

All of these tasks are ongoing; specific panels and reviews will be identified in annual workplans.

Years 4-7 CBDA Science Program Task Needs – Collaborative Science and Communication

Task	\$ in millions				
	Year 4	Year 5	Year 6	Year 7	sub total
Bay Delta Science Consortium	0.5	0.5	0.5	0.5	2.0
E-journal and Science Conference	0.5	0.5	0.5	0.5	2.0
Summaries for Managers	0.2	0.2	0.2	0.2	0.8
Science Boards, panels, peer review	2.0	2.0	2.0	2.0	8.0
sub total	3.2	3.2	3.2	3.2	
				TOTAL	12.8

Support the Development of New Science Within CALFED Programs

This task involves Science Program support to individual CALFED programs to help identify science needs, develop research agendas, and provide matching funds for experts and synthesis activities. During Year 4, Science Program activities will include:

- assisting the water management program conduct a review of CALSIM II and set up a standing panel to review technical issues associated with storage; and
- assisting the Drinking Water Program establish and frame a charge for an independent panel of advisors, and assisting in developing conceptual models for water quality monitoring in the Delta.

Years 4-7 CBDA Science Program Task Needs – Supporting the Development of New Science Within Individual CALFED Programs

Task	\$ in millions				
	Year 4	Year 5	Year 6	Year 7	sub total
Support new science within CALFED Programs	1.0	1.0	1.0	1.0	4.0
sub total	1.0	1.0	1.0	1.0	
				TOTAL	4.0

Budget Summary

Task Needs Summary: CBDA Science Program Years 4-7

Task	\$ in millions				
	Year 4	Year 5	Year 6	Year 7	sub total
Water Operations and Biology	7.1	3.0	2.0	2.0	14.1
Performance Assessment	1.0	1.0	1.0	1.0	4.0
Signature Adaptive Management Projects	0.5	2.4	2.1	2.5	7.5
Improving Monitoring Capabilities	2.1	2.4	2.1	2.5	9.1
Collaborative Science and Communication	3.2	3.2	3.2	3.2	12.8
Supporting New Science Within CALFED Programs	1.0	1.0	1.0	1.0	4.0
Fund CDFG and DWR staff working on CALFED Science Issues	0.8	0.8	0.8	0.8	3.2
sub total	15.7	13.8	12.2	13.0	54.7
IEP	14.0	14.0	14.0	14.0	56.0
				TOTAL	109.4

Stage 1 Funding

Science Funding ¹ (\$ in millions)	Program Year							Total
	1	2	3	4	5	6	7	
State	\$15.53	\$3.75	\$4.08	\$22.54	\$14.61	\$8.23	\$1.26	\$70.00
Federal	\$6.08	\$9.22	\$5.91	\$5.70				\$26.91
Local/Water User	\$6.61	\$7.32	\$7.33	\$6.61	\$6.42	\$6.42	\$6.42	\$47.13
Revised Stage 1 (Actual & Expected Funding) ²	\$ 28.22	\$ 20.29	\$ 17.32	\$ 34.85	\$ 21.03	\$ 14.65	\$ 7.68	\$144.04
Original ROD (Aug, 2000) ³	\$25.00	\$30.00	\$45.00	\$50.00	\$50.00	\$50.00	\$50.00	\$300.00
Revised ROD (Dec, 2002) ⁴	\$40.00	\$45.00	\$60.00	\$65.00	\$65.00	\$65.00	\$65.00	\$405.00

¹ Includes funding for the Science Program and the Interagency Ecological Program (IEP).

² Funding for Years 1-2 reflects actual State encumbrances & expenditures and grant matching funds from federal, state, and local funding sources. Funding for Year 3 reflects final State and Federal budgets. Funding for Year 4 reflects proposed Governor's and President's budgets. Expected funding in Years 5-7 includes remaining state bond funds until spent and ongoing State base funding. Federal appropriations for Years 5-7 are unknown; therefore, federal funding is not included beyond Year 4.

³ Original Stage 1 funding estimates from the Record of Decision. Funding for the IEP was not included in these estimates.

⁴ ROD estimates for the Science Program have not been revised, but funding estimates for the IEP (\$15 million per year) have been added.

Attachment A
Excerpts from the CALFED Record of Decision (ROD) Related to Science
(Referenced by page number and, in some cases, section)
Pages 77-79

2.2.12 Science

This ROD establishes the CALFED Science Program, which will bring world-class science to all elements of the program; ecosystem restoration, water supply reliability, water use efficiency and conservation, water quality, and flood management (e.g., levee stability). Performance measures and indicators for each program element will track progress.

The purpose of the CALFED Science Program is to provide a comprehensive framework and develop new information and scientific interpretations necessary to implement, monitor, and evaluate the success of the CALFED Program (including all program components), and to communicate to managers and the public the state of knowledge of issues critical to achieving CALFED goals.

The Science Program will be developed and directed by an interim lead scientist, who will also serve in the role of lead scientist during the initial years of program implementation. Implementation of the CALFED Science Program includes implementation of the Comprehensive Monitoring, Assessment and Research Program (CMARP), now under the direction of the interim lead scientist. The Science Program also has primary responsibility to establish the role of adaptive management in program implementation, implement strategies to reduce uncertainties that impede successful accomplishment of CALFED goals, provide programmatic review of overall implementation of mitigation measures and integrate the CALFED Science Program with existing/related agency science programs.

An overarching principle of the Science Program is adaptive management. Adaptive management is defined as using and treating actions as partnerships between scientists and managers, designing those actions as experiments with a level of risk commensurate with the status of those species involved, and bringing science to bear in evaluating the feasibility of those experiments. New information and scientific interpretations will be developed through adaptive management, as the programs progress, and will be used to confirm or modify problem definitions, conceptual models, research, and implementation actions.

In order to better integrate scientific review into the CALFED Program, the Governor and the Secretary of the Interior will appoint an independent science board to provide oversight and peer review for the overall program. Also, specific independent science panels may be convened as standing bodies or on an as needed basis. For example, the Science Program will assist with convening an independent science panel to review implementation and operation of the EWA. In addition, the existing ERP Interim Science

Board will likely become the ERP Science Panel, and provide ongoing independent review of the ERP.

While much of the need for scientific review is often focused on habitat restoration efforts, the CALFED Science Program will cover all of the program components. Water supply reliability, water use efficiency and conservation, water quality, and flood management/levee stability can each benefit from the periodic review of an independent science panel to help ensure the best investments are being made and results are being achieved, as well as form strategies to reduce scientific uncertainties. The interim lead scientist will work with CALFED program managers and CALFED Agencies to develop priorities for these program areas.

In early Stage 1, the emphasis for the CALFED Science Program will be on ecosystem restoration activities, including design of effective monitoring, targeted research and development of priorities. These efforts will be based initially on the 12 uncertainties identified in the ERP Strategic Plan.

The Science Program will not be directly involved in making regulatory decisions, but rather in ensuring that CALFED, and the CALFED Agencies, are incorporating the best available knowledge into activities and decisions that are made, as well as continuously working toward narrowing scientific uncertainties, bettering knowledge, and advancing the debate. The CALFED Science Program will be conducted in an open and collaborative manner to allow and encourage involvement of stakeholder and academic science communities. The CALFED Science Program can serve as a science clearinghouse for the CALFED Agencies and identify and articulate areas of scientific uncertainty relevant to key issues.

Actions Included in the Programmatic EIS/EIR The CALFED Science Program will accomplish the following in Stage 1:

- Appoint an independent science board for the CALFED Program as a whole by the middle of 2001.
- Appoint an independent science panel for the EWA by the middle of 2001.
- Coordinate existing monitoring and scientific research programs.
- Refine the set of ecological, operational and other predictive models that will be used in the evaluative process by the end of 2001.
- Establish performance measures and indicators, and a consistent strategy of on-going development of these, for each of the program areas.
- Develop an annual science report, format and content, which includes:
- Status of the species and effectiveness of efforts to improve conditions, including EWA, ERP and water management strategies, and provide recommendations to maximize fishery benefits while minimizing impacts to water supply.
- Assessment of progress and effectiveness of each program element as indicated by performance measures and indicators.
- Complete feasibility study to establish and construct CALFED Science Center.
- Recommended research and/or program adjustments.
- Prepare first annual report by the end of 2001.

CALFED intends to invest approximately \$300 million in the science program during Stage 1. 77-79

Science Within Individual Programs

40 The ERP will be informed by the **Science Program**, which will monitor and evaluate the implementation of the ERP actions and conduct pertinent research. The ERP and the **Science Program** are important for Federal Endangered Species Act (FESA), California Endangered Species Act (CESA) and Natural Community Conservation Plan (NCCP) compliance, and are integral to the MSCS.

To ensure that substantial progress in being made to achieve the MSCS-ERP Milestones, the USFWS, NMFS, and DFG will participate in an annual process with the ERP and **Science Programs** to: 1) develop annual and long-term ERP implementation priorities and strategies; 2) develop annual implementation plans; and 3) assess the implementation and performance of ERP actions, including measuring progress towards achieving the MSCS-ERP Milestones. **40**

43 The major Stage 1 elements of the Watershed Program include: Developing watershed program performance measures and monitoring protocols consistent with the CALFED **Science Program** by the end of 2002. **43**

70 As part of the CALFED **Science Program**, develop a comprehensive monitoring and assessment program by the beginning of 2003 (of the source controls in the Delta and its tributaries) **70**

81 As with ERP implementation priorities and strategies generally, USFWS, NMFS, and DFG intend that the Science Program will inform the MSCS-ERP Milestones. Specifically, USFWS, NMFS, and DFG will seek annual review within the Science Program of 1) whether other program elements conflict with ERP implementation priorities and strategies so as to limit the success of the ERP, and 2) whether the ERP implementation priorities and strategies will ensure that the Program as a whole continues to increase aquatic and terrestrial habitats and improve ecological functions in the Bay- Delta. As the Science Program develops information about ERP implementation, USFWS, NMFS, and DFG will revise the MSCS-ERP Milestones as necessary, consistent with the FESA and NCCPA. **81**

127 Long-term implementation of the Ecosystem Restoration Program will be guided by the adaptive management approach described in the Strategic Plan for Ecosystem Restoration. This approach to restoration will require review by an ecosystem restoration science review panel and will rely on information developed in the Science Program. **127**

130 The Watershed Program includes the following elements: Develop watershed program performance measures and monitoring protocols consistent with the CALFED Science Program. **130**

135 The lead agencies and the Science Program of the CALFED Program will monitor the mitigation used for second-tier projects. **135**

138 Projects and activities that implement the CALFED Preferred Program Alternative will be monitored through the Science Program to ensure that issues and mitigation strategies in this EIS/EIR process are adequately considered and used to develop mitigation measures for second-tier projects. (re Mitigation Monitoring Plan) **138**

267 Science Review Panel: The CALFED Science Program will convene a scientific panel familiar with the EWA and its operations. The Management Agencies and Project Agencies will keep this panel informed on a monthly basis through the CALFED Ops Group reporting process. **267**

268 The panel will convene on an annual basis to review the EWA operations. **268**

287 Science-Based Adaptive Management Approach: The Agencies will implement the CALFED Program using a science-based adaptive management approach. This approach will rely on constant monitoring and evaluation of actions in all Program Elements. The CALFED Science Program will provide information to guide management decisions for CALFED Program actions, and CALFED related actions. **287**

289 The Program Staff, under the direction of the Policy Group and in coordination with the Agencies will: Manage the CALFED Science Program, under the leadership of a Lead Scientist. **289**

293-294 Science The purpose of the CALFED Science Program is: (1) to provide a comprehensive framework for developing new information and scientific interpretations necessary to implement, monitor, and evaluate the success of the CALFED Program (including all Program Elements); and (2) to communicate to managers and the public the state of knowledge of issues critical to achieving CALFED goals. The scope of the CALFED Science Program will include scientific information necessary for the CALFED Program and for State and Federal water operations.

Specific objectives include:

- Provide a comprehensive and integrated scientific context for CALFED activities
- Ensure continuous advancement of credible scientific information that will guide regulatory decisions, adaptive management, and water project operations
- Establish a framework to identify and articulate areas of scientific uncertainty relevant to key issues both before and after actions
- Develop strategies to reduce uncertainties and track performance and progress toward CALFED goals

The work described in the Comprehensive Monitoring, Assessment, and Research Program (CMARP) technical appendix (Final EIS/EIR, July 2000) is now under the direction of the CALFED Science Program. **293-294**

320 – 323 CALFED Science Program

Functions and Responsibilities: The CALFED Science Program will provide one Comprehensive Monitoring, Assessment and Research program to serve all the CALFED Program Elements. This will be accomplished by building on the foundation of existing agency and stakeholder science programs, including the Interagency Ecological Program (IEP). IEP consists of representatives from USGS, Reclamation, FWS, EPA, NMFS, USACE, SWRCB, DWR, DFG, and stakeholder communities.

The Science Program will be neither fully independent, nor fully imbedded in the CALFED Program Elements. Rather, the Science Program will provide a balance of independent review/oversight to ensure credibility. The CALFED Science Program will have a role in performing and/or overseeing the following functions:

1. Planning and Priorities
2. Monitoring
3. Data Management
4. Assessment (e.g. status and trends, project, regional)
5. Research
6. Trial Implementation Actions
7. Reporting
8. Independent Science Review
9. Coordination

Lead Scientist and Program Staff : The Science Program will be directed by a Lead Scientist that reports directly to the CALFED Executive Director. The Science Program will be developed and directed by an Interim Lead Scientist, who will also serve in the role of Lead Scientist in the initial years of Program implementation.

The Lead Scientist will facilitate integration among Program Elements, especially where technical issues and outcomes of actions have implications for more than one Program Element. The Lead Scientist will be supported by a technical staff member who will interface with Program Staff, scientists, other technical experts and agency staff from other related programs, including regulatory staff. Science Program staff will not actually do fieldwork and data collection, but will direct and integrate science and management activities with a focus on the "big picture." Some Science Program Staff will be dedicated to specific CALFED Program Elements and will have joint reporting responsibility to both the Lead Scientist and the respective Program Manager. Each CALFED Program Element will retain science/technical staff, as appropriate, with responsibilities for their particular program and coordination with the CALFED Science Program.

The Lead Scientist has the responsibility to assure that monitoring is conducted to provide information to assess progress toward meeting goals and objectives of the CALFED Program. The Lead Scientist is responsible for establishing an overall monitoring strategy and performance measures for CALFED. System-wide status and trends monitoring and regional monitoring are particular responsibilities of the Lead

Scientist with oversight of the monitoring of individual projects conducted by the Program Elements. Coordination of monitoring components among CALFED Program Elements is part of this responsibility.

With regard to research, the Lead Scientist will be responsible for CALFED producing studies that are relevant, authoritative and objective. The studies should progressively reduce uncertainties about critical issues, add to the knowledge that aids water management and ecosystem restoration, and help prepare for future uncertainties. Identifying the state of knowledge will be accomplished by white papers, workshops of experts, or other objective, expert-based analyses. Prioritization of research will begin with the 12 uncertainties specified in the ERP Strategic Plan.

The Lead Scientist has the responsibility for making sure that the findings of the CALFED Science Program are shared with the Policy Group, Program managers, the public, and the scientific community.

Adaptive Management: An overarching principle of the Science Program is adaptive management. Adaptive management is defined as using and treating actions as partnerships between scientists and managers, designing those actions as experiments with a level of risk commensurate with the status of those species involved, and bringing science to bear in evaluating the feasibility of those experiments. New information and scientific interpretations will be developed via adaptive management as the programs progress, and will be used to confirm or modify problem definitions, conceptual models, research, and implementation actions.

Adaptive management will be conducted within the programs, and as such must be carried out within the programs. However, the Lead Scientist will, in collaboration with the programs, develop a general strategy with regard to the scientific aspects of the adaptive management. The strategy will be common among the programs to the extent possible. The Lead Scientist will report annually to the Executive Director and the Policy Group on the implementation by the CALFED Program of science and the scientific aspects of the adaptive management process.

Science Coordination Team: Consistent with FACA, the Science Program will establish a Science Coordination Team chaired by the Lead Scientist to assist in implementing the Science Program. The team will consist of technical experts and scientists from the CALFED Agencies and stakeholder communities implementing and or monitoring major elements of the CALFED Program. Agency/stakeholder technical workgroups will be formed to assist in defining and implementing various aspects of the Science Program. For example, the existing Agency/Stakeholder Ecosystem Team (ASET) will likely continue to provide assistance to implementing the ERP.

Independent Science Review: The Science Program is committed to extensive external peer review and extensive use of expert technical panels to clarify the state of knowledge and recommend scientific directions. The Science Program will include two levels of independent review: a standing Independent Science Board for the entire CALFED Program, and a variety of Science Panels focused on specific programs/issues.

The Independent Science Board will be responsible for advising the Science Program and CALFED Executive Director on key scientific issues as well as providing periodic reviews of the quality and effectiveness of the CALFED Science Program itself.

Program/issue specific Science Panels may be standing bodies or convened on an as needed basis. For example, an independent EWA Science Panel will be convened before the end of 2001. Also, the existing ERP Interim Science Board will likely become the ERP Science Panel and provide ongoing independent review of the ERP.

Mitigation Monitoring: It is the responsibility of the Science Program to review the overall efficacy of mitigation and to identify areas of uncertainty about mitigation approaches or areas that require more monitoring or study.

In order to fulfill this requirement, the lead agencies responsible for environmental review of project-specific actions will assure that appropriate programmatic mitigation, as well as project-specific mitigation measures are adopted, implemented, and monitored periodically, but at least annually. The lead agencies will report on their progress to Program Managers. Program Managers will evaluate and report their assessments to the Lead Scientist.

The Lead Scientist will provide a summary of this information to the Executive Director and Policy Group as a portion of the Annual Report described in Section E of this MOU.

Interface with Regulatory Actions: There will be a formal role for the Lead Scientist in advising on regulatory issues which entails:

- review and clarify the state of knowledge
- identify critical areas of study that could narrow uncertainties and ensure that such studies are on going
- oversee and coordinate regional monitoring
- advise programs about the composition of advisory committees
- coordinate broad reviews and assessments of the detectable environmental responses to regulatory decisions and management actions and use that information to feedback into the plans for future actions and evaluations of those actions

The Lead Scientist will identify, through consultation with stakeholders and technical experts, controversial issues that have arisen in previous regulatory activities and set up a process to address, clarify and make progress toward resolving those issues.

The role of the Science Program will be one of guidance, review, and overall performance assessments. Independence from day-to-day activities is needed to assure the credibility of reviews and studies designed to reduce uncertainties and facilitate better management. The Lead Scientist (and Science Program) will not be directly involved in making regulatory decisions, but rather in ensuring that CALFED and the CALFED agencies are incorporating the best available knowledge into activities and decisions that are made, as well as continuously working toward narrowing

uncertainties, improving that knowledge and advancing the debate. The Science Program will not be involved in day-to-day management decisions regarding water operations and the EWA. **320-323**

340-341 The Ecosystem Restoration Program. The Program's objectives for ecosystem restoration are to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta Estuary and its watershed to support sustainable populations of diverse plant and animal species. The **Ecosystem Restoration Program** ("ERP") is the principal Program element designed to meet these objectives. Implementation of the ERP will be coordinated with by the **Science Program**, which will conduct pertinent research, and monitor and evaluate the implementation of ERP actions. The ERP and the Science Program are directly relevant and important for FESA, CESA and NCCPA compliance and are integral to the MSCS. To ensure that the ERP is implemented in a manner and to an extent sufficient to sustain programmatic FESA, CESA and NCCPA compliance for all Program elements, the Fishery Agencies have collaborated to develop a single, joint list of MSCSERP Milestones ("Milestones") for Stage 1 of Program implementation. Each Fishery Agency included the Milestones in its Biological Opinions. The Milestones include ecosystem related water quality actions and may include specific Science Program actions. The Fishery Agencies agree that the identified Milestones, if achieved as specified in the Agencies' Biological Opinions, will define an adequate manner and level of ERP implementation for each stage of Program implementation. The Parties agree to seek funding for and to implement the ERP so as to ensure that the Milestones are achieved. To be successfully implemented, the ERP must be funded in the amount of at least \$150 million annually through Stage 1. **340-341**

365 Proposed Levee System Integrity Program Stage 1 Actions: Implement current Best Management Practices (BMPs) to correct subsidence effects on levees. Assist CALFED Program's Science Program activities to quantify the effect and extent of inner-island subsidence and its linkages to all CALFED Program objectives (yr 1-7). **365**

395-397 *CALFED Science Program*

The CALFED Science Program includes implementing the Comprehensive Monitoring, Assessment, and Research Program (CMARP) as an integral aspect of the overall CALFED Program. The scope of the Science Program will encompass all elements of the CALFED Program: ecosystem restoration, water supply reliability, water use efficiency and conservation, water quality, and levees integrity. The purpose of the Science Program is to provide new information and scientific interpretations necessary to implement, monitor, and evaluate the success of the CALFED Program. The Science Program will build on the work of the Interagency Ecological Program and other scientific efforts in the CALFED Program area.

The CALFED Program is organized around the concept of adaptive management because there is incomplete knowledge of how the ecosystem functions, the effects of human stressors on ecosystem structure and function, and the ecological and other effects of individual CALFED Program actions. Monitoring key system functions (or indicators), completing focused research to obtain better understanding, and staging implementation based on information gained are all central to the adaptive management process.

In order to better integrate scientific review into the CALFED Program, the Governor and the Secretary of the Interior will appoint an independent science board to provide oversight and peer

review for the overall program. Also, specific independent science panels may be convened as standing bodies or on an as needed basis. For example, the Science Program will assist with convening an independent science panel to review implementation and operation of the EWA. In addition, the existing ERP Interim Science Board will likely become the ERP Science Panel, and provide ongoing independent review of the ERP.

Proposed Science Program Stage 1 Actions

The CALFED Program will evaluate the following Science Program actions proposed for implementation in Stage 1. These proposed Stage 1 actions are representative of the overall set of proposed actions for the Science Program.

- Periodic review and refinement of the monitoring, data assessment and research plan from a long term perspective (yr 1-7).
- Periodic review and refinement of the monitoring, data assessment and research plan from a short term perspective which would include all elements of the Phase III, Stage 1 Program (yr 1-7).
- Help management define triggers and time periods which determine the need for a change in program direction (yr 1-7).
- Continue to develop and refine conceptual models to be used in evaluating actions undertaken by the programs. In keeping with the adaptive management format, the models will be continually updated with information generated by program actions (yr 1-7).
- Evaluate the effectiveness of the adaptive management process on the program decision making process (yr 1-7).
- Review the progress toward achieving overall CALFED Program goals and objectives and whether individual programs are progressing at similar paces (yr 1-7).
- Complete monitoring identified by the Diversion Effects on Fisheries Team to provide feedback on actual diversion effects of south Delta pumps (yr 2-7).
- Design long-term, system wide, baseline monitoring with focused research to increase understanding of ecological processes and ways to reduce uncertainty; definition of needed studies is currently under development (yr 1-7).
- Provide available data on need to reduce bromides, total dissolved solids, total organic carbon, pesticides and heavy metals (yr 5).
- Provide available data on water quality in the south Delta and lower San Joaquin River (yr 1-7).
- Monitor and assess the impacts of water use efficiency measures on water demands and available supplies, and develop better information for water balances in the Bay-Delta system (yr 1-7).
- Prepare annual reports on status and progress, including such information as: status of the species and effectiveness of efforts to improve conditions, including EWA, ERP and water management strategies, and provide recommendations to maximize fishery benefits while minimizing impacts to water supply (yr 1-7).
- Analyze status and need for adjustments of actions for later stages (yr 5-7).
- Monitor and report land use changes, such as agricultural land conversion, resulting from CALFED Program actions (yr 2-7).
- Hire an interim science leader and subsequently hire a chief scientist (yr 1-2).
- Appoint an Independent Science Board and an independent science panel for the EWA (yr 1-2).
- Coordinate existing monitoring and scientific research programs (yr 1-7).
- Refine the set of ecological, operational, and other predictive models that will be used in the evaluation process (yr 1-2).
- Establish and refine performance measures and indicators for each of the program areas (yr 1-7). **395-397**

407 *Water Use Efficiency Program*

Development and implementation of the WUE will be consistent with the goals and objectives of the ERP and MSCS, including State and Federal recovery plans. Program actions and associated conservation measures will be planned in conjunction with the Service, NMFS, and CDFG, in compliance with FESA, CESA, and NCCPA, as appropriate. Program development will be coordinated with other CALFED Programs (WQP, ERP, MSCS, and Science Program). **407**

410 Science Program

The Science Program will complete annual reports describing program progress and compliance of all CALFED program actions within this biological opinion. **410**

479 Effects of CALFED Program Elements: Science Program

The Science Program will largely benefit listed species through implementation of the CMARP. CMARP will support monitoring and research presently not available for many species and their habitats, and will monitor implementation and progress of other CALFED Programs. Through monitoring, research, and assessment of species and program implementation, CMARP is expected to contribute information and recommendations to CALFED Agencies and stakeholders in support of the adaptive management process. Information developed by the Science Program will contribute to the recovery of listed and proposed species.

The Science Program is likely to result in capture, harassment, injury, death, and collection of listed species. These effects will occur during monitoring as part of implementing other CALFED Programs, during baseline monitoring of species populations, and as a part of conducting research projects. The potential effects of Science Program activities will be avoided and minimized by authorizing only qualified biologists to capture and handle listed species while conducting monitoring and research. To achieve this, these activities will be authorized only through the Section 10(a)(1)(A) Recovery Permitting process, or through subsequent, tiered, section 7 biological opinions, which will incorporate the same standards as the Recovery Permitting process. **479**

507 The CALFED Program includes a framework guiding implementation that addresses the scope, complexity, and duration of the CALFED Program, and the relative uncertainty regarding the CALFED Program's approach in resolving issues in the problem areas. Implementation is supported by an Implementation Plan that describes Stage 1 actions, CALFED Program integration, governance, and financing. In addition, a Science Program is included to carry out monitoring, assessment and research; and a MSCS will be followed to achieve compliance with the ESA. **507**

510 Proposed Levee System Integrity Program Stage 1 Actions: Implement current Best Management Practices (BMPs) to correct subsidence effects on levees. Assist CALFED Program's Science Program activities to quantify the effect and extent of inner-island subsidence and its linkages to all CALFED Program objectives (yr 1- 7). **510**

535-536 Science Program

The CALFED Science Program includes implementing the Comprehensive Monitoring, Assessment, and Research Program (CMARP) as an integral aspect of the overall CALFED Program. The scope of the Science Program will encompass all elements of the CALFED Program: ecosystem restoration, water supply reliability, water use efficiency and conservation, water quality, and levees integrity. The purpose of the Science Program is to provide new information and scientific interpretations necessary to

implement, monitor, and evaluate the success of the CALFED Program. The Science Program will build on the work of the Interagency Ecological Program (IEP) and other scientific efforts in the CALFED Program area.

The CALFED Program is organized around the concept of adaptive management because there is incomplete knowledge of how the ecosystem functions, the effects of human stressors on ecosystem structure and function, and the ecological and other effects of individual CALFED Program actions. Monitoring key system functions (or indicators), completing focused research to obtain better understanding, and staging implementation based on information gained are all central to the adaptive management process.

In order to better integrate scientific review into the CALFED Program, the Governor and the Secretary of the Interior will appoint an independent science board to provide oversight and peer review for the overall program. Also, specific independent science panels may be convened as standing bodies or on an as needed basis. For example, the Science Program will assist with convening an independent science panel to review the implementation and operation of the EWA. In addition, the existing ERP Interim Science Board will likely become the ERP Science Panel, and provide ongoing independent review of the ERP.

The CALFED Science Program will accomplish the following in stage 1:

- Appoint an independent science board for the CALFED Program as a whole by the middle of 2001.
- Appoint an independent science panel for the EWA by the middle of 2001.
- Coordinate existing monitoring and scientific research programs.
- Refine the set of ecological, operational, and other predictive models that will be used in the evaluative process by the end of 2001.
- Establish performance measures and indicators, and a consistent strategy of on-going development of these, for each of the program areas.
- Develop an annual science report, format and content, which includes:
 - Status of the species and effectiveness of efforts to improve conditions, including EWA, ERP and water management strategies, and provide recommendations to maximize fishery benefits while minimizing impacts to water supply.
 - Assessment of progress and effectiveness of each program element as indicated by performance measures and indicators.
 - Complete feasibility study to establish and construct CALFED Science Center
 - Recommend research and/or program adjustments.
- Prepare first annual report by the end of 2001

CALFED intends to invest approximately \$ 300 million in the science program during stage 1.

Other Proposed Science Program Stage 1 Actions

In addition, the CALFED Program will evaluate the following Science Program actions proposed for implementation in Stage 1. These proposed Stage 1 actions are representative of the overall set of proposed actions for the Science Program.

- Periodic review and refinement of the monitoring, data assessment and research plan from a long term perspective (yr 1-7).
- Periodic review and refinement of the monitoring, data assessment and research plan from a short term perspective which would include all elements of the Phase III, Stage 1 Program (yr 1-7).
- Help management define triggers and time periods which determine the need for a change in program direction (yr 1-7).
- Continue to develop and refine conceptual models to be used in evaluating actions undertaken by the programs. In keeping with the adaptive management format, the models will be continually updated with information generated by program actions (yr 1-7).
- Evaluate the effectiveness of the adaptive management process on the program decision making process (yr 1-7).
- Review the progress toward achieving overall CALFED Program goals and objectives and whether individual programs are progressing at similar paces (yr 1-7).
- Complete monitoring identified by the Diversion Effects on Fisheries Team to provide feedback on actual diversion effects of south Delta pumps (yr 2-7).
- Design long-term, system wide, baseline monitoring with focused research to increase understanding of ecological processes and ways to reduce uncertainty; definition of needed studies is currently under development (yr 1-7).
- Provide available data on need to reduce bromides, total dissolved solids, total organic carbon, pesticides and heavy metals (yr 5).
- Provide available data on water quality in the south Delta and lower San Joaquin River (yr 1-7).
- Monitor and assess the impacts of water use efficiency measures on water demands and available supplies, and develop better information for water balances in the Bay-Delta system (yr 1-7).
- Prepare annual reports on status and progress, including such information as: performance of habitat restoration actions compared to expected results, summaries of any new information on the relative importance of various stressors, and any need for adjustments in actions or conceptual models (yr 1-7).
- Analyze status and need for adjustments of actions for later stages (yr 5-7).
- Monitor and report land use changes, such as agricultural land conversion, resulting from CALFED Program actions (yr 2-7).
- Hire an interim science leader and subsequently hire a chief scientist (yr 1-2).
- Appoint an Independent Science Board and an independent science panel for the EWA (yr 1-2).
- Coordinate existing monitoring and scientific research programs (yr 1-7).
- Refine the set of ecological, operational, and other predictive models that will be used in the evaluation process (yr 1-2).
- Establish and refine performance measures and indicators for each of the program areas (yr 1-7). **535-536**

542 Specifically, the fish and wildlife agencies will seek review within the Science Program of 1) whether other Program elements conflict with implementation priorities and strategies so as to limit the success of the ERP, MSCS, and WQP, and 2) whether the

implementation priorities and strategies will ensure that the Program as a whole continues to increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta. As the Science Program develops information about implementation, the USFWS, NMFS and CDFG will revise the Milestones as necessary, consistent with the FESA and the NCCPA. **542**

548 *Science Program.* The Science Program will complete annual reports describing program progress and compliance of all CALFED program actions within this biological opinion. **548**

576-577

Science Program

Implementing the Science Program may adversely affect anadromous salmonids through take of fish during monitoring and research efforts. However, overall beneficial effects are expected because the Science Program will obtain, analyze, and interpret modeling results and data that will be used to guide implementation of the different CALFED programs and strategies. The success of programs and actions continually will be evaluated, and the Science Program will provide recommendations for adaptive management that is to promote species restoration. CALFED will use the Science Program to measure progress towards meeting prescriptions for MSCS evaluated species primarily by monitoring the distribution and abundance of habitat types over time. Many of the programs and actions proposed by CALFED have not been implemented previously on a large scale (e.g., installation of setback levees) or a statewide scale (e.g., the WUEP). The beneficial effects of implementing other more common actions, such as restoration of wetlands or shaded riverine aquatic habitat, are not well understood. Information obtained through the Science Program will lead to better understanding and greater ability to predict the effects of implementing particular actions on salmonids and other species.

Science program monitoring and research activities that should provide information used to promote restoration of anadromous salmonids include studies of food web and fish population dynamics in the Delta, real-time monitoring for enhanced fish protections and flexible operations for water suppliers, and water quality monitoring in the San Joaquin River. Many of the actions proposed under the ERP, WQP, and other CALFED programs involve monitoring and research components. These components will be implemented in coordination with the Science Program. Additionally, the Science Program likely will inherit several ongoing monitoring and research studies from the IEP. These studies may form the basis for long-term data sets that contain both pre- and post-CALFED data, which may prove critical for evaluating the overall success of CALFED.

Monitoring and research of juvenile salmonids in the Bay-Delta system likely will involve their collection during periodic fish sampling. Collection methods may include electroshocking in shallow, freshwater areas. Outmigrant trapping or trawling are commonly used in deeper or more saline locations. These collection methods all may lead to mortality of fish, although the greatest mortality likely would occur from trawling due to abrasion of fish while the trawl is in motion. Electroshocking and

outmigrant trapping equipment and techniques have been improved in recent years to reduce fish mortality, but still would physically and physiologically stress fish. Delayed mortality or permanent injury may be incurred. Fright responses or minor injuries resulting from collection or handling may temporarily impair feeding or increase vulnerability to predation or injury once fish are released.

Sampling mortality of juvenile salmonids is expected to be acceptably low if normal precautions against it are taken. Electroshocking equipment may be adjusted to reduce mortality or injury. Stress or injury resulting from handling may be reduced if juvenile salmonids are anesthetized prior to handling, and allowed to recover from the effects of the anesthetic prior to release (Summerfelt and Smith 1990). Juvenile salmonids, if anesthetized and held in cool water, tend to be robust compared to larval salmonids or other species such as delta smelt. Monitoring and research that is to occur through the Science Program likely will be conducted by experienced crews using established sampling protocols that have explicit take limits established through consultation with the fish and wildlife agencies.

Data collected from adult steelhead and chinook salmon likely will be collected in upstream areas by observation only (e.g., by snorkeling, at fish passage facilities, or during redd counts). Snorkel observations may be the preferred method of data collection for juvenile salmonids in upstream areas as well. Because these methods do not involve physically handling the fish, their effects likely would be limited to minor, temporary fright responses. Carcass surveys may similarly disturb remaining live adult steelhead or chinook salmon that are preparing to spawn. **576-577**

578 The CALFED Program is to be implemented in stages over a period of 30 years. Project descriptions and funding sources have been most clearly identified for actions that are to occur during Stage 1 (i.e., the first 7 years of Phase III). However, the CALFED Governance Program provides a framework that includes the following provisions for oversight of both short- and longterm implementation:

- # Using the Science Program to direct research and monitor impacts to species populations. Research and monitoring related to Stage 1 actions will be used to develop adaptive management strategies and direct implementation of later actions. CALFED objectives will remain fixed over time, but the actions may be adjusted to assure that the solution is durable. Adaptations are expected to be necessary as conditions change and as more is learned about the system and how it responds;

- # Using species-specific, Stage 1 milestones to ensure that beneficial impacts of the CALFED Program are significant, broad, and occur at an acceptable pace. These milestones have been developed from the ERP/WQP targets and programmatic actions, and MSCS conservation measures. The milestones also include Science Program actions that are relevant for ERP, WQP, and MSCS implementation. Progress toward attaining all milestones will be continually reviewed by the resource agencies. Milestones may be revised to provide for the protection of species through adaptive management **578**

643 Adaptive Management, Monitoring and Reporting: The ROD establishes the CALFED Science Program, which will bring world-class science to all elements of the CALFED Program. The Science Program will be developed and directed by an interim

lead scientist, who will also serve in the role of lead scientist during the initial years of CALFED Program implementation. Implementation of the Science Program includes implementation of the Comprehensive Monitoring, Assessment, and Research Program (CMARP), now under the direction of the interim lead scientist.

In recognition of the uncertainties inherent in any program of this magnitude, the CALFED Program includes provisions for applying an adaptive management process based on comprehensive monitoring and assessment of program implementation. This process ensures that the CALFED Program and the MSCS can be modified, as appropriate, to use consistently the best information regarding evaluated species and the most effective, practical means for achieving their goals. For the CALFED Program as a whole, the Science Program will help refine program actions based on monitoring results. The adaptive management components of the MSCS are described in Chapter 7 and Chapter 8 of the MSCS. These chapters describe how the CALFED Program will periodically evaluate the effectiveness of the conservation measures and modify these measures when necessary. **643**

646 The CALFED Program includes a framework guiding implementation that addresses the scope, complexity, and duration of the CALFED Program, and the relative uncertainty regarding the CALFED Program's approach in resolving issues in the problem areas. Implementation is supported by an Implementation Plan that describes Stage 1 actions, CALFED Program integration, governance, and financing. In addition, a Science Program is included to carry out monitoring, assessment and research; and a MSCS will be followed to achieve compliance with the ESA. Implementation of the CALFED Program will be guided by an adaptive management approach with monitoring of performance to help modify (adapt) future actions and contribute to decision making. Also, the CALFED Program will be guided by the principle of balanced implementation of CALFED Program elements. **646**

648 *Proposed Levee System Integrity Program Stage 1 Actions*

Implement current Best Management Practices (BMPs) to correct subsidence effects on levees. Assist CALFED Program's Science Program activities to quantify the effect and extent of inner-island subsidence and its linkages to all CALFED Program objectives (yr 1- 7). **648**

665 *Water Management Strategy (WMS)*

The tools that will be used to achieve the goals and objectives of the WMS include: the WUE Program (agricultural, urban, and wetland water conservation and water recycling); the Water Transfer Program; Conveyance, including South Delta Improvements; Storage; and, operational strategies, such as real-time diversion management and an EWA. In addition to these primary tools, the WMS will rely on additional CALFED Program tools to provide additional benefits. These include the Watershed Program, the Water Quality Program, and real-time monitoring through the Science Program. **665**

677-680 *CALFED Science Program*

The CALFED Science Program includes implementing the Comprehensive Monitoring, Assessment, and Research Program (CMARP) as an integral aspect of the overall CALFED Program. The scope of the Science Program will encompass all elements of the CALFED Program: ecosystem restoration, water supply reliability, water use efficiency and conservation, water quality, and levees integrity. The purpose of the Science Program is to provide new information and scientific interpretations necessary to implement, monitor, and evaluate the success of the CALFED Program. The Science Program will build on the work of the Interagency Ecological Program and other scientific efforts in the CALFED Program area.

The CALFED Program is organized around the concept of adaptive management because there is incomplete knowledge of how the ecosystem functions, the effects of human stressors on ecosystem structure and function, and the ecological and other effects of individual CALFED Program actions. Monitoring key system functions (or indicators), completing focused research to obtain better understanding, and staging implementation based on information gained are all central to the adaptive management process. A preliminary CMARP report is an appendix to the Final Programmatic EIS/EIR. This report identified objectives and functions of CMARP, developed a conceptual framework for CMARP, presented a preliminary monitoring and focus research program design, and recommended an institutional structure for CMARP. Some actions pursued under the Science Program will result in take, and therefore will require authorization under NCCPA and/or CESA and section 7 or section 10(a)(1)(B) of the ESA.

Functions of the CALFED Program's Science Program include:

- < Developing and refining ecological conceptual models.
- < Identifying monitoring and research needs to support implementation and the evaluation of the CALFED Program. This includes program performance measures and indicators; also a monitoring plan for the ERP is being developed.
- < Data management, assessment, and reporting.
- < Providing for and coordinating independent scientific/technical review of the technical aspects of the CALFED Program.

The institutional structure of the Science Program is not completely determined at this time. The ERP has established an Interim Science Board to provide the ERP with independent scientific guidance and review. The CALFED Program's Management Group has appointed a temporary Science Oversight Team to accomplish the following tasks for the Science Program:

- < Develop science questions associated with Stage 1 management decisions.
- < Develop functions and structure of the Science Program.
- < Develop an initial list of program performance measures and indicators.
- < Assess feasibility of a Bay-Delta science center.
- < Develop coordination plans for science programs relevant to the CALFED Program.
- < Clarify issues of implementing adaptive management under the CALFED Program.

Proposed Science Program Stage 1 Actions

The CALFED Program will evaluate the following Science Program actions proposed for implementation in Stage 1. These proposed Stage 1 actions are representative of the overall set of proposed actions for the Science Program.

- < Periodic review and refinement of the monitoring, data assessment and research plan from a long term perspective (yr 1-7).
- < Periodic review and refinement of the monitoring, data assessment and research plan from a short term perspective which would include all elements of the Phase III, Stage 1 Program (yr 1-7).
- < Help management define triggers and time periods which determine the need for a change in program direction (yr 1-7).
- < Continue to develop and refine conceptual models to be used in evaluating actions undertaken by the programs. In keeping with the adaptive management format, the models will be continually updated with information generated by program actions (yr 1-7).
- < Evaluate the effectiveness of the adaptive management process on the program decision making process (yr 1-7).
- < Review the progress toward achieving overall CALFED Program goals and objectives and whether individual programs are progressing at similar paces (yr 1-7).
- < Complete monitoring identified by the Diversion Effects on Fisheries Team to provide feedback on actual diversion effects of south Delta pumps (yr 2-7).
- < Design long-term, system wide, baseline monitoring with focused research to increase understanding of ecological processes and ways to reduce uncertainty; definition of needed studies is currently under development (yr 1-7).
- < Provide available data on need to reduce bromides, total dissolved solids, total organic carbon, pesticides and heavy metals (yr 5).
- < Provide available data on water quality in the south Delta and lower San Joaquin River (yr 1-7).
- < Monitor and assess the impacts of water use efficiency measures on water demands and available supplies, and develop better information for water balances in the Bay-Delta system (yr 1-7).
- < Prepare annual reports on status and progress, including such information as: performance of habitat restoration actions compared to expected results, summaries of any new information on the relative importance of various stressors, and any need for adjustments in actions or conceptual models (yr 1-7).
- < Analyze status and need for adjustments of actions for later stages (yr 5-7).
- < Monitor and report land use changes, such as agricultural land conversion, resulting from CALFED Program actions (yr 2-7).
- < Hire an interim science leader and subsequently hire a chief scientist (yr 1-2).
- < Appoint an Independent Science Board and an independent science panel for the EWA (yr 1-2).
- < Coordinate existing monitoring and scientific research programs (yr 1-7).
- < Refine the set of ecological, operational, and other predictive models that will be used in the evaluation process (yr 1-2).
- < Establish and refine performance measures and indicators for each of the program areas (yr 1-7). **677-680**

691 Summary of Key Planned Actions *Science Program*. The Science Program will complete annual reports describing program progress and compliance of all CALFED program actions within this NCCPA Approval and biological opinions. **691**

701 Adaptive Management. Flexible, iterative approach to long-term management of natural communities, habitat types, and species within the plan area.

As described in the Introduction, the CALFED Program includes provisions for applying an adaptive management process, which is an overarching principle of the Science Program. The Strategic Plan describes, in detail, the adaptive management process that will be employed to implement the ERP (Strategic Plan, Chapter 3). The adaptive management components of the MSCS are described in Chapter 7 and Chapter 8 of the MSCS. The CALFED Program will periodically evaluate the effectiveness of the conservation measures for NCCP communities and evaluated species and modify these measures when necessary. The CALFED Program's strategic approach for implementation includes staged implementation and staged decision making (Implementation Plan, Chapter 1). Throughout the implementation period, monitoring will provide information about overall conditions in the Bay-Delta and on the status and trends of natural communities. Clearly, adaptive management is emphasized throughout the CALFED Program as the process by which program implementation will occur. **701**

Attachment B

Science Program – Organizational Goals and What We’re Doing

Goal: [Articulate, test, refine, and grow understandings about natural and human systems](#)

What we’re doing:

- Investing in Critical Unknowns
- Implementing Regional Signature Projects
- Filling Monitoring Gaps
- Fostering Adaptive Management
- Conducting Science in Support of Management
- Investing in Analysis of Data

Goal: [Integrate Use of Best Available Scientific Understandings and Practices Throughout CALFED](#)

What we’re doing:

- Peer Review
- Partnerships & Collaboration
- Promoting Publication
- Enhancing Public Access to Data

Goal: [Provide Authoritative & Unbiased Descriptions of the State of Scientific Knowledge](#)

What we’re doing:

- Issue Workshops
- White Papers

Goal: [Evaluate Technical Performance of CALFED Program](#)

What we’re doing:

- Science Board Reviews
- Using Expert Panels and Advisors
- EWA Technical Review
- Performance Measures

Goal: [Establish and Improve Communication Pathways between Science, Management, and Public Communities](#)

What we’re doing:

- Science Conferences
- Educational Material
- New Science Journal
- Fact Sheets
- Science Program Activity Report

Attachment C

Rationale for Year 4-7 Issue Agenda

The following is a description of the strategic approach used to select priority activities for the CALFED-wide Science Program over the next three years.

- Provide information that will inform the major decisions that the Authority must make in the near future on water operations, conveyance, flow management, restoration and storage (for example); and that will allow interpretation of the net, system-wide effects of these actions when taken together. But be aware that understanding processes in the system is probably the shortest path to providing such information.
- Identify, and attempt to quickly eliminate, the obvious and simpler critical bottlenecks in knowledge. There are some opportunities for gains in understanding in the shorter-term and these should be exploited. For example, it is probably feasible to soon develop better understanding of factors involved in direct losses of delta smelt and salmonids at the intakes to federal and state pumping plants in the Delta. Although ultimately we must understand the implications of take for populations, there is also benefit to better understanding and managing take, especially as it is defined as a critical goal of existing and proposed management actions.
- Take the long view –do not use relatively short timelines as a constraint to addressing important, but difficult issues. And develop understanding over time - the program will be revisiting activities and strategies over a long period of time so understanding should be directed at future evaluations as well as those that are currently
- Use available funds, personnel and time to address feasible questions and issues. The balance between long- and short-term gain is necessary because many very important questions are not feasible to resolve in the short-term. Much effort can be wasted on projects that raise short-term expectations but address questions that are not feasible to resolve in the short-term.
- Focus on the most important factors limiting success in achieving goals. It is rare that single factors control the response of an ecosystem, community or population of organisms (for example), but at the extremes, at least, it is sometimes known which factors are more important than others. Factors with minor influences are the least important to fully understand.
- Recognize the importance of more than one target species, with the short list including longfin smelt, Sacramento splittail, green sturgeon, and steelhead, in addition to delta smelt and Chinook salmon.
- Recognize the importance of understanding ecosystem characteristics, processes and functions, and ecosystem-level responses that will affect the success of achieving CALFED goals.
- Clarify the status of knowledge. Workshops in which the science program identifies the status of knowledge, and, in a balanced manner, discusses assumptions and uncertainties in that status are key to the establishing the credibility of the science used to support decisions by the Authority's member agencies. A continuing and

aggressive flow of such information is critical to communication among scientists, agencies and the many collaborators in the Authority's programs.

- Provide an iterative feedback loop between scientists and managers to clarify both knowledge assumptions and uncertainties, and to reduce uncertainty in our understanding of key populations and ecosystem processes and our ability to manage them.

Attachment D
Summary of Science Activities: Year 3

Water Operations and Biology in the Delta: Science Issues

- Studies & Monitoring Underway
 - Effects of toxicants on juvenile salmon – reconnaissance study in south delta to see if effects can be detected
 - Fundamental hydrodynamic and transport mechanisms in the Delta
 - Genetic identification methods for spring run Chinook salmon in the Sacramento watershed
 - Replaced in-situ flow monitoring equipment in the Delta
 - The spatial ecology and population dynamics of Delta smelt revealed by otolith biogeochemistry
 - Delta Cross Channel studies (funded initial year, cost-shared with Conveyance Program)
 - IEP fish presence, abundance, and location data – identifying patterns and controlling processes
 - Interpretation of larval fish data: Sponsored symposium and edited publication of papers
- Workshops and Reviews
 - Water Management workshop: population-level effects
 - Salmon and EWA water management workshop
 - Delta smelt workshop
 - Evaluate implications of climate variability and climate change for water management and proposed CALFED Actions
 - Review of Delta Cross Channel proposals and progress
 - Workshop on Resource valuation
 - Develop synthesis of knowledge relevant to converging issues on water operations and environmental management in the delta and hold related workshop(s).
 - EWA Technical Review
 - Convene annual review by independent panel and issue report
 - Publish summaries of year's activities, justifications and summaries of workshops
- Science Agendas and White Papers
 - Delta smelt research agenda – sponsored development of a multi-organization IEP project work team and complete agenda for science needs both for IEP and for PSP.
 - Complete Delta smelt white paper
 - Complete salmonid white paper
 - Improving science underlying water operations: initiate process of selecting and starting studies using science agenda developed in Year 2 as basis for PSP
 - Determining effectiveness of Delta fish screens in the broader ecosystem context: initiate PSP and select studies to improve science linking take to ecosystem conditions and populations

Performance Measures

- Expand to a white paper the philosophy, process and formats used for CALFED performance measures.
- Produce annual report on progress in developing performance measures for CALFED and CALFED programs
- Using ERP as a model, characterize and justify metrics, and interpret trends, in an initial set of key indicators.
- Began development of a conceptual model for evaluating changes in supply reliability at different scales associated with CALFED actions
- Providing expert advisor to help each program develop and use performance measures
- Establish peer review process for selection of indicators and written explanations.

Signature Adaptive Management Projects

- Stockton Ship Channel:
 - Studies & Monitoring Underway:
 - Development of long-term hydrological models in support of dissolved oxygen management in Stockton ship channel and San Joaquin river
 - Workshops and Reviews:
 - Expert panel for multidisciplinary review of Delta projects linked to flow and water quality changes (San Joaquin River DO)
- Battle Creek:
 - Begin science advisory process
 - Panel discussion of state of Science

Improve Monitoring Capabilities

- Complete aquatic monitoring white paper
- Analyses of under-exploited monitoring data
 - Collaborate with CA Sea Grant to solicit, select and fund proposals for postdoctoral research in several issue areas
 - Collaborate with IEP to integrate peer review into the proposal-workplan development and selection process
- Review of Collection, handling, trucking and release studies for Delta smelt (associated with salvage from diversion facilities).
- IEP-SAG review of salmon monitoring
- Replaced old real-time flow monitoring equipment in Delta
- Wetlands
 - Co-sponsor research on indicators linking toxicants to wetland ecological health- UC Davis
 - Pilot Wetlands Monitoring – organize multidisciplinary team to develop methods and conduct integrated monitoring of restoration sites from San Pablo Bay to the Delta

Restoration Science: An Adaptive Management Approach

- Studies and Monitoring Underway: Science Program-sponsored
 - Ecological evaluation of Yolo bypass to support floodplain restoration
 - Heavy metal and mercury concentrations in bed sediments and floodplains of Clear Creek watershed
 - Invasive species in ports and harbours
 - Developing a flow and sediment transport model for channel and floodplain restoration on the Sacramento River
- Workshops and Reviews
 - Supporting statewide strategic science plan for mercury studies & coordination of CALFED mercury studies
 - In-stream flow modeling workshop (Year 2)
 - Support implementation of recommendations from ERP Science Board's adaptive management workshop
 - Support ongoing expert panel review of Upper Yuba River studies
 - Workshop on floodplain restoration
- Science Agendas and White Papers
 - Sediment budget and controlling processes throughout the watershed – putting restoration plans in the context of sediment availability
 - White paper: Progress in Delta restoration
 - Update science agendas on restoration science in each ERP region;
 - Follow up on science agenda for shallow water habitat management in the Delta

Creation of a Bay-Delta Consortium for Collaborative Science

- Provided staff and start-up funds for the Bay Delta Science Consortium, including planning co-location of DWR, CDFG, USFWS, and USGS scientists and field staff
- Developing criteria for collaborative proposals
- Discussing a collaborative focus on Suisun Marsh

Communication

- Initiated development of communication strategy for the Science Program
- Conferences
 - 2nd CALFED Science Conference, Sacramento, January 2003
 - Co-Sponsoring 2003 State of the Estuary Conference
 - Co-Sponsoring Pacific Climate Conference 2002
 - Co-Sponsoring Society of Environmental Toxicology and Chemistry Conference, 2002
 - Co-Sponsored AFS Early Life History Meeting, 2003
 - Co-Sponsoring American River Conference, 2002
- Educational Material
 - Scientific studies in the Delta--video
 - Water Education Foundation Delta Flow Video
- Online Science Journal

- Funded the development of a new online series devoted to publication of scientific studies on water issues in California; journal editors have accepted two manuscripts for review and the digital publication process is starting
- Fact Sheets
 - *Science in Action*: Delta Cross Channel studies fact sheet published in *Estuary*
 - *Science in Action*: Delta shallow water habitat fact sheet published in *Estuary*
 - River restoration fact sheet in progress
- Science Program Activity Reports (selected examples)
 - Presentation at Estuarine Research Federal conference on adaptive management experiments within CALFED Bay-Delta Program
 - Briefed US GAO on the structure of the Science Program
- Web Site: Initiated development of Science Program web site

Program Specific Science

- Levees
 - Delta island subsidence and accretion (cost share with DWR)
 - Shallow water habitat science agenda
- Drinking Water Quality and Environmental Water Quality
 - Delta water quality: analysis of existing data to establish a baseline water quality (cost-shared with Drinking Water Program)
 - Share in developing independent science review process for PSP
 - Developing conceptual models and monitoring strategy
 - Performance measures under development
 - Funded studies
- Ecosystem Restoration Program
 - Update peer review process in PSP (ERP)
 - Fund ~\$10M scientific studies to support restoration, selected in competitive process
 - Begin performance measures
 - Adaptive Management forums: Merced, Clear Creek, Tuolumne
 - Sustain science advisory board (Independent Science Board-ISB)
 - Brown-bag science/restoration seminars every month
 - Planning adaptive management experiments with ISB
 - Support science blueprint from Prop. 204
 - Statewide mercury study strategy
 - Begin studies of feasibility of restoring salmonids in Upper Yuba
- Conveyance
 - Co-sponsored peer review of north Delta flood models with Levee Program
 - Advising on technical panel for Through Delta Facility studies
 - Supporting adaptive management Delta cross channel studies
- Storage
 - Continue review of portions of the Delta Wetlands technical studies
 - Initiating Process to peer review CALSIM and its applications
- WUE
 - Providing advice to WUE on defining the role of an external science review committee
- Water Management

- Arsenic White Paper – geochemical and microbial processes, drinking water use, and potential conjunctive use issues (Water Management)
 - Butte Basin ground water and linked models (peer review and advise on process)
- Science
 - Engaged in discussions with the National Academy of Sciences and developed plans for a review of the Science Program in spring, '03 (Science Program)

Attachment E

Criteria for Independent Experts Serving on Scientific Review and Advisory Panels

Independent experts are defined by their academic credentials in specific areas of needed expertise. Except in specifically defined circumstances, they have little or no direct stake in the issue for which they are advisors. The experts are typically paid for their work by the Authority, unless they are federal or state employees (whose hours may be reimbursed to their employer). Typical activities of independent experts include the following.

1. Bringing detailed expertise to bear on scientific issues of concern to CALFED. This may include characterizing the status of knowledge about critical issues; identifying key scientific issues, or helping staff prioritize issues. Other duties include organizing or participating in workshops on critical subjects, and/or identifying, proposing, prioritizing, or writing white papers or reviews. Some expert advisors have identified pending issues before they become critical or worked directly with managers, staff biologists, or operating engineers to help them take into account broader scientific practices, principles and implications.
2. Reviewing, advising or providing technical insights for documents, proposals or programs. Programs can include either issues that require multiple studies or proposals for an action by the Authority or its member agencies, such as changes in conveyance, threats to levees, and restoration strategies.
3. Analyzing existing data related to specific actions or programs as relevant to reviews or advising as described above.
4. Designing, conducting, or leading studies relevant to accomplishing CALFED goals that are not in conflict with review roles.

Qualifications of Independent Experts

Independent experts are agents for facilitating communication between the Authority and the scientific and management community. Therefore they must have the highest level of expertise and stature so that their advice is respected by the public, scientists, agency technicians, CALFED staff, and management. The ability to sustain a balanced view of issues is just as important as stature in an independent expert. It is critical that the expert (or advisor) have a reputation for willingness to listen to opposing views, willingness to change one's mind in the face of evidence contrary to an original view, and willingness to separate one from biases associated with employment or professional associations.

Thus, invitation to be an independent expert requires all or most of the following:

- Scientific stature. Evidence of stature in the broad scientific community (invited contributions to workshops, conferences or panels; evidence of scientific leadership; awards, membership, or important committee assignments in prestigious organizations).

- Advisory experience. Experience advising top managers and promoting constructive uses of environmental science, especially in arenas relevant to water management and/or ecosystem restoration.
- Technical publications. A strong record of publication in peer-reviewed scientific literature in an area of expertise relevant to the issues at hand.
- Relevant knowledge. Evidence of extensive and/or intensive working knowledge of a scientific field related to the specific issues of concern.
- People skills. Evidence of abilities to work and communicate well with people.
- Reputation for achieving balance. Evidence of ability to weigh issues in a balanced manner when in an advisory capacity.
- Interdisciplinary skills. Evidence of ability to work and think across disciplines, and/or experience in working with and advising on complex issues that integrate multiple disciplines.

Attachment F Bay Delta Science Consortium



Bay-Delta Authority agencies are joining forces with university researchers, stakeholders and other scientists to share information and resources on the Bay-Delta watershed.



This collaborative effort forms the new Bay-Delta Science Consortium. The Consortium will focus on one of the most important – and threatened – ecosystems on

the West Coast, California's Bay-Delta Estuary, through an array of scientific activities. From water quality monitoring to habitat and fisheries research, a broad range of programs are underway to understand and improve the health of the Bay-Delta watershed, and provide feedback on the effectiveness of Bay-Delta actions.

Member Agencies and Institutions:

Agencies

California Department of Fish and Game
California Department of Water Resources
U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service
U.S. Geological Survey
U.S. Environmental Protection Agency
City of Rio Vista

Non-profits

Point Reyes Bird Observatory
San Francisco Estuary Institute
Natural Heritage Institute

Universities

California State University
Hayward
San Francisco
Sacramento
University of California, Davis

Bay-Delta Science Consortium

CURRENT ACTIVITIES AND KEY GOALS



Joint Facilities and Research Stations

Consortium members will be:

- Co-locating agency and university scientists at new facilities in Davis and Rio Vista.
- Establishing a network of field stations throughout the region (see map on reverse).



Common Data Management Systems

Consortium members are helping implement the Science Program's distributed data management strategy:

- Helping researchers locate and utilize meaningful data from a wide range of sources.



New Electronic Journal

The Consortium is helping launch a new electronic journal, debuting in 2003:

- Serving as a forum for discussing science in the Program and publishing peer reviewed technical reports written by and for the Program community.



Collaboration

The Consortium enhances collaboration efforts by:

- Organizing forums where scientists can exchange ideas and develop multi-disciplinary projects.
- Providing feedback to the Program on collaborative proposals.



New web site

<http://www.baydeltaconsortium.org>

- Helping scientists share information on current and planned research, monitoring and outreach activities.

Attachment G
Summary of Funded Projects

Program Element	Year Funded	Recipient	Grant Amount
Science Program Directed Action for Ecological Evaluation of Yolo Bypass to Support Floodplain Restoration	2001	DWR	\$395,500
Co-Sponsored Development of Data Management	2002	DWR	\$25,000
Genetic Identification Methods for Splittail in the Sacramento Watershed	2002	UC Davis	\$256,544
Hydrodynamic and Transport Mechanisms in the Delta	2002	USGS	\$1,100,000
Pilot Wetland Monitoring - Multidisciplinary Integrated Studies (Phase I)	2002	Multiple	\$1,309,318
Pilot Wetland Monitoring – Multidisciplinary Integrated Studies (Phase II)	2002	SFSU	\$2,449,847
Co-Sponsored Delta Island Subsidence and Accretion Analysis	2002	USGS	\$240,000
Co-Sponsored Initiation Process to Peer Review CALSIM and Its Applications	2002	ABAG	\$95,479
Co-Sponsored Peer Review of North Delta Flood Models with Levee Program	2002	ABAG	\$15,000
Co-sponsored Research on Indicators linking Toxicants to Wetland Ecological Health	2002	UC Davis	\$250,000
Co-Sponsored Symposium and Edited Publication Papers on Larval Fish	2002	UC Santa Cruz	\$10,000
Delta Water Quality: Analysis of Existing Data to Establish a Baseline	2002	Univ. of Washington	\$231,225
Effects of Toxicants on Juvenile Salmon	2002	UC Davis	\$162,000
Flow and Sediment Transport Model for Channel and Floodplain Restoration on the Sacramento River	2002	UC Santa Barbara	\$390,352
Heavy Metal and Mercury Concentrations in Bed Sediments and Floodplains of Clear Creek Watershed	2002	Univ. of Montana	\$183,146
Hydroacoustic Surveys to Determine the Distribution of Fish in the Sacramento River Near the Delta Cross Channel	2002	USBR	\$88,829
Hydrological Models in Support of Dissolved Oxygen	2002	San Joaquin Dissolved Oxygen	\$500,000
Interagency Ecological Program Fish Presence, Abundance, and Location Data	2002	USGS	\$496,000
Invasive Species in Ports and Harbors	2002	USC	\$111,192
Replaced In-Situ Flow Monitoring Equipment in the Delta	2002	USGS	\$262,706
Research Studies Including the Tagging of Salmon Smolt to Determine migratory Routes Near the Delta Cross Channel Under Different Tides and Gate Operations	2002	San Luis & Delta-Mendota Water Agency	\$26,660

Research Studies of the Migratory Pathways of Adult Salmon, Sturgeon, and Striped Bass and the Influence of the Delta Cross Channel	2002	CDFG	\$385,057
The Spatial Ecology and Population Dynamics of Delta Smelt Revealed by Otolith Biogeochemistry	2002	UC Davis	\$88,312